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LATEST IMPROVEMENTS TO THE LEACHING CIRCUIT AT NEW BRITANNIA MINE

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Latest Improvements to the Leaching Circuit at New Britannia Mine

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ABSTRACT

Three years ago, the New Britannia Mine started a project to improve productivity of its cyanidation plant. Results indicated that gold dissolution was strongly influenced by sulphide minerals and that the slower gold dissolution rate had a detrimental effect on overall gold recovery. The leaching strategy had to be modified to address this issue. Changes to the leaching circuit proved to be very successful. The first action was to introduce lead nitrate in the leaching circuit. The strategy of addition of lead nitrate was upgraded in three steps. An on-line free cyanide analyser was installed and the strategy of cyanide addition automated. The enhancement of the leaching kinetics have resulted: a 4% increase of gold recovery, from 87.8% in 1996 to 91.9% in 1999, which represents a reduction of 0.17 g/t Au in the leach residue; an average of 1330 additional extracted gold ounces per year from 1997 to 1999; a 21% reduction in the cyanide consumption; the shut down of the cyanide destruction plant; and finally a contribution to the 27% reduction in the overall production cost per tonne of ore ($3 per ton). The significant increase of the throughput was instrumental in the reduction of the processing cost. In 1999, the improvement of gold recovery represented an additional gross revenue of ^{CDN}1.9 Million. The project is discussed in details in this paper.

INTRODUCTION

In August 1997, the introduction of lead nitrate addition in the cyanidation practice significantly improved the plant performance. Modifications of the practice was based on experimental testwork conducted by CANMET and New Britannia Mine plant results. The results of the cyanidation study was presented in a previous paper (1). Additional changes to the plant practice, such as the strategy of lead nitrate addition and the strategy of cyanide addition and control were subsequently brought. This report presents the latest results related to these modifications to the leach circuit and their impact on the overall plant performance.

DISCUSSION

The New Britannia Mine processes a free milling gold ore with a grade of 4.35 g/t Au. The material is ground to 88-90% -74 µm. Most of the gold is free milling (92%). Mineral identification indicates that the ore has 87% gangue minerals (quartz, albite, chlinochlore and biotite), 6.2% ankerite, 3.0% arsenopyrite and 2.7% pyrite. The remaining gold is in solid solution in arsenopyrite and to a minor extent in pyrite and chalcopyrite.(1)

The retention time of the leaching circuit was 53 h in 1997. The laboratory results indicated that the leaching kinetics are much faster with the addition of lead nitrate and the equilibrium can be reached in 24 hours as illustrated in Figure 1. The first modification brought to the circuit is shown in Figure 2. The first tank was used for a 10-hour pre-leaching and lead nitrate was added at 50 g/t. Lead nitrate was added manually, in a solid form, every 2 hours. Cyanide was transferred to leach tank #2. The addition of lead nitrate proved to be very beneficial. The actual plant performance resulted in a 1.3% increase in the gold extraction rate, from 90.2% to 91.5%. The retention time for gold leaching was consequently decreased to 43 h. A gross revenue increase of about ^{CDN}720,000 was reported for 1998.

Test work indicated that the addition of lead nitrate directly to cyanidation was found to be less effective. Indeed, with the addition directly to cyanidation, the leaching kinetics are slower. Further laboratory investigation indicated that a short pre-leaching can be as efficient as the 10 hour pre-leaching already applied in 1998. The effect of the duration of pre-leaching is illustrated in Figure 3. For the gold extraction, the system reached an optimum at 0.5-hour pre-leaching with a gold extraction of 89.4%. After the optimum, there is a very low decrease in gold extraction. As a result of this information resulted in the use of the grinding circuit for pre-leaching and to utilise totally the tankage for gold leaching as indicated in Figure 4. Lead nitrate addition was consequently moved to grinding. Lead nitrate was still added manually, in a solid form, every 2 hours, on the rod mill feed belt. Cyanide addition was moved back to the first leach tank. The main advantage of these modifications is that the increased throughput can be processed without any loss in the gold dissolution rate.

This modification of the cyanidation circuit

proved to be correct and allowed to increase the processing rate simultaneously with the increase of gold extraction. The throughput was increased for 2010 tpd in 1998 to 2155 tpd in 1999. The leaching parameters used in 1998 and in 1999 are illustrated in Table 1. The following modification was to add lead nitrate on a continuous basis, in a liquid form (18% solution strength), to the ball mill discharge box. Lead is now received in 500 kg totes and dissolved in water on an average of every 4 days. This has drastically reduced the operators exposure to lead.

Laboratory results indicated that particle-size had no significant effect on gold extraction from 89% to 96% -74 µm and, it was decided to maintain the same target for grinding. The cyanidation study indicated that the control of the free cyanide concentration has an effect on gold leaching kinetics and reagent consumption. To improve the control of this variable, an on-line free cyanide analyzer was installed in September 1998. A cyanide control system, developed by Degussa Huels, was installed and described in a previous paper (2). The cyanide control system has allowed to better control the free cyanide levels in the leach circuit by the following improvements: 1) in-situ filtration; 2) a more accurate silver nitrate titration with a potentiometric end point with an accuracy below 5%; 3) sample frequency of 4 times per hour, and 4) automatically controlled dosing valve.

The automation allowed higher confidence and accuracy than manual control. With no negative effect on the overall gold extraction, the free cyanide was reduced from 400 ppm to 275 ppm in the first leach tank and from 200 ppm to 100 ppm in the last leach tank (Table 1). The impact of this modification was a 21% reduction of the cyanide consumption (from 0.67 kg/t in 1996 to 0.53 kg/t in 1999) as illustrated in Figure 5.

The dramatic reduction of the free cyanide level in the mill tailings contributed to the shutdown of the cyanide destruction process (INCO SO_2/Air process) in March 1998. The annual cyanide destruction costs are illustrated in Figure 6. New Britannia now utilises natural degradation and ferric sulphate for effluent treatment. The lowered yearly NaCN costs and the elimination of the INCO SO_2/Air circuit resulted in major operating cost savings of $600,000, while still meeting all effluent discharge parameters as set out by the Manitoba Government.

Table 2 shows the progression of the plant throughput from 1996 to 1999. From 1997, the throughput has increased by 14% (from 688,146 tons to 786,501 tons. In parallel, the gold extraction continuously increased from 90.2%, in 1997, to 91.9% in 1999. The gold content of the leach residue, on a year basis is illustrated in Figure 7. As an examples, for 1999, there was a 4.1% improvement of gold recovered, which represents an additional gross revenue of ^{CDN}1.9 Million. All of these improvements significantly reduced the milling cost, which has been lowered by 27% since 1997 (^{CDN}3.0).

CONCLUSIONS

The gold dissolution rate is strongly influenced by sulphide minerals that slow the gold leaching kinetics and decrease the overall gold recovery. Lead nitrate addition overcomes the detrimental effect of sulphide minerals. Laboratory investigations, used in combination with plant performance data, is a very effective approach to optimise a leaching circuit. Modifications to the leaching circuit and improvement of control contributed to a 4% increase in gold recovery and a 27% reduction in production cost. In 1999, the improvement of gold recovery represented an additional gross revenue of ^{CDN}1.9 Million. The introduction of an on-line free cyanide analyser resulted in major cost savings: 21% reduction of the cyanide consumption and was the main contributor of the shutdown of the cyanide destruction process (SO_2/air process).

Table 1. New Britannia Mine Cyanidation Operating Details

Item \ Year	1998	1999
Feed throughput (t/d)	2010	2155
Pre-leaching time (h)	10	0.5
Tailing (g/t Au)	0.38	0.34
No. of pre-leaching tanks	1	0
Cyanidation time (h)	43	50
No. of cyanidation tanks	4	5
Total leach tankage (m^3)	5267	6284
Slurry pH initial, leaching	11.2	11.1
Slurry pH final, leaching	10.4-10.0	10.2-10.0
Cyanide addition (kg/t)	0.65	0.44
Free cyanide conc., initial (mg/L NaCN)	400	275
Free cyanide conc., final (mg/L NaCN)	225-175	75-100
Lead nitrate addition (g/t)	40-50	45-50
Lead nitrate addition (S or L)	S	S & L*
Dissolved oxygen conc., initial (ppm)	6-8	6-8
Dissolved oxygen conc., final (ppm)	8-10	8-10
Pulp agitation (rpm)	25	25

* Lead Nitrate at 18% solution strength in October 1999

Table 2. New Britannia Mine Tonnage Throughput, Cyanide Consumption and Gold Extraction

Year	Tons	NaCN (kg/t)	Au Extraction (%)	Residue (g/t Au)	Additional Au (oz)
1996	556,349	0.69	88.0	0.51	----
1997	688,146	0.67	90.2	0.45	1328
1998	733,720	0.58	91.5	0.38	1651
1999	786,501	0.53	92.1	0.34	1011

ACKNOWLEDGMENTS

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2- Healey, S., Norcross, R. and Roy, D., (1999) "Automated Cyanide Control at New Britannia" Proc. Ann. Mtg. Canadian Mineral Processors, Ottawa; January 1999, 411-424.

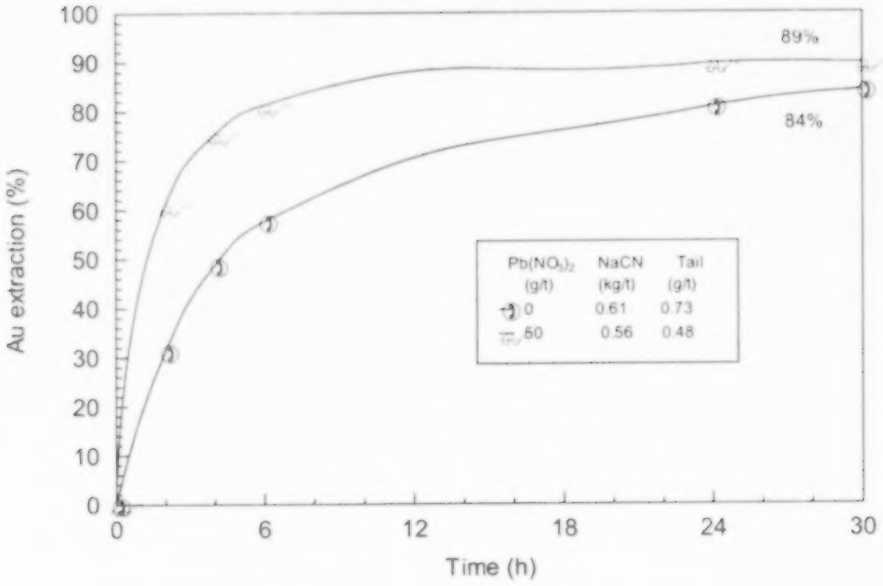

Figure 1. Gold leaching kinetics for New Britannia Mine ore (1).

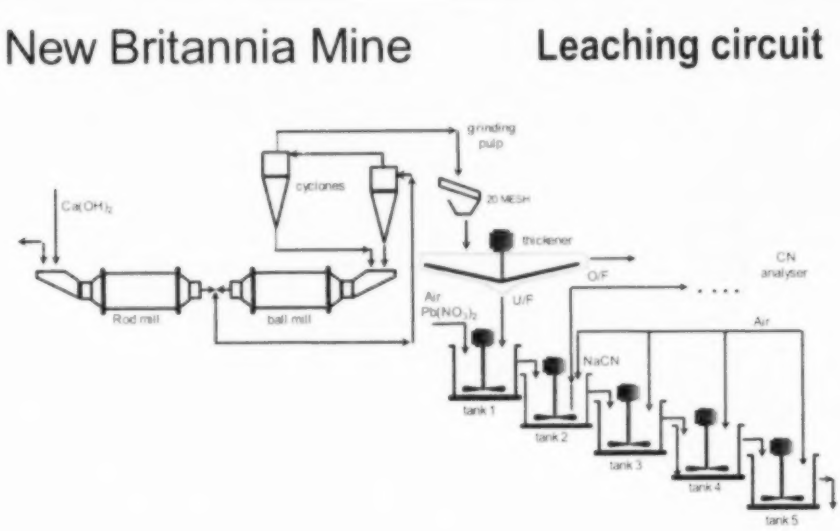

Figure 2. First modification to the New Britannia Mine leach circuit.

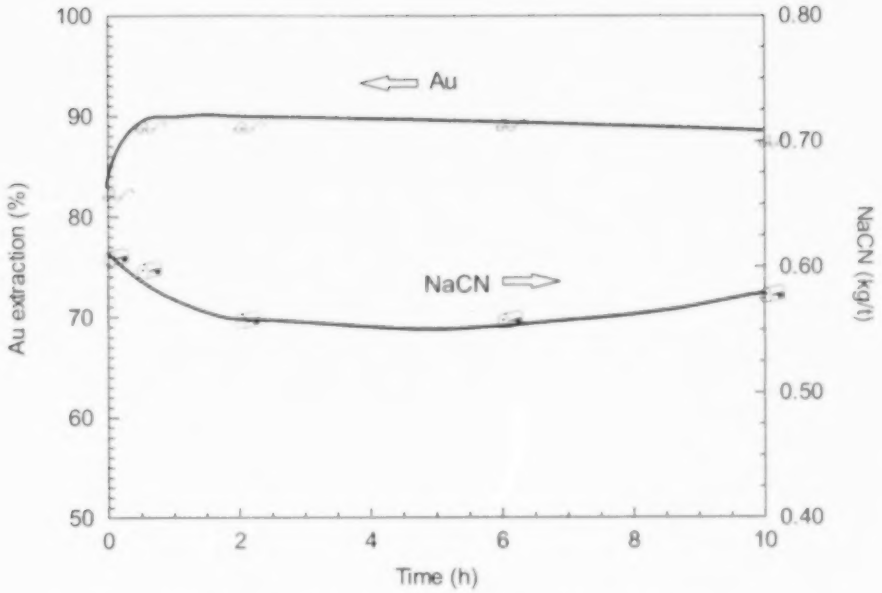

Figure 3. Effect of the duration of the pre-leaching on gold leaching of the New Britannia Mine ore.

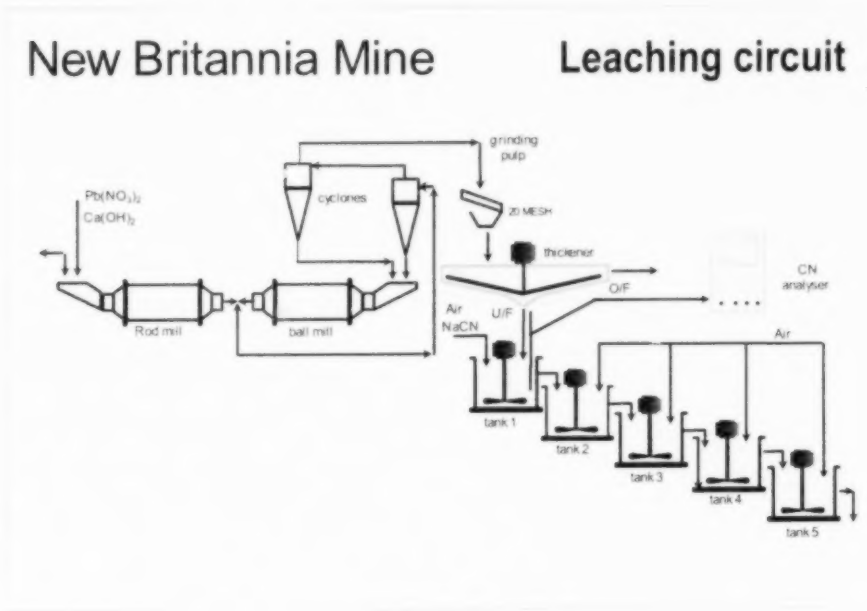

Figure 4. Second modification to the New Britannia Mine leaching circuit.

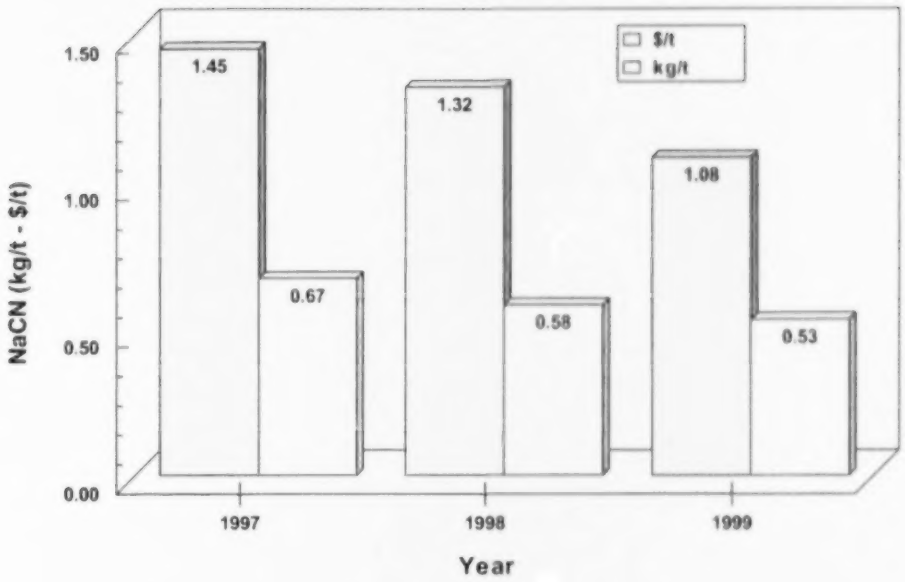

Figure 5. Cyanide consumption of the New Britannia Mine.

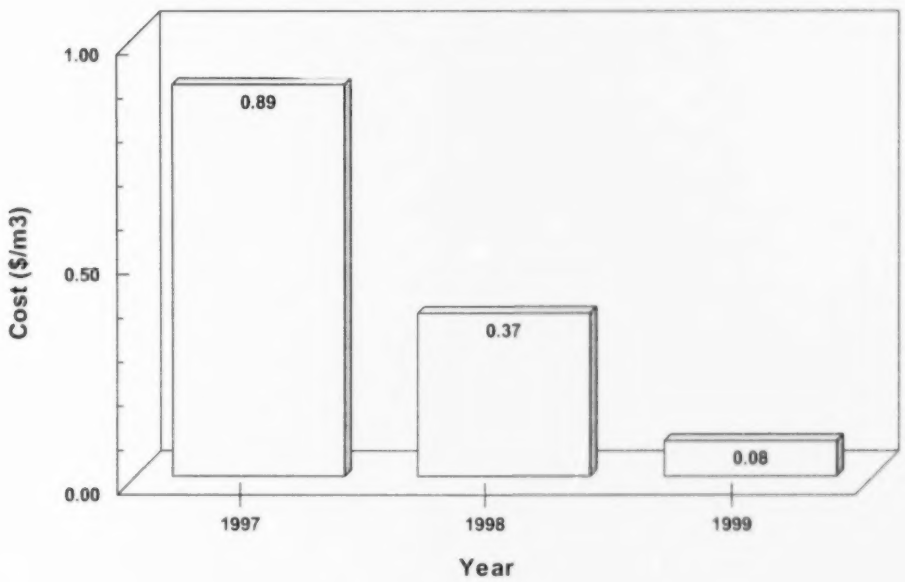

Figure 6. Annual cyanide destruction costs for the New Britannia Mine.

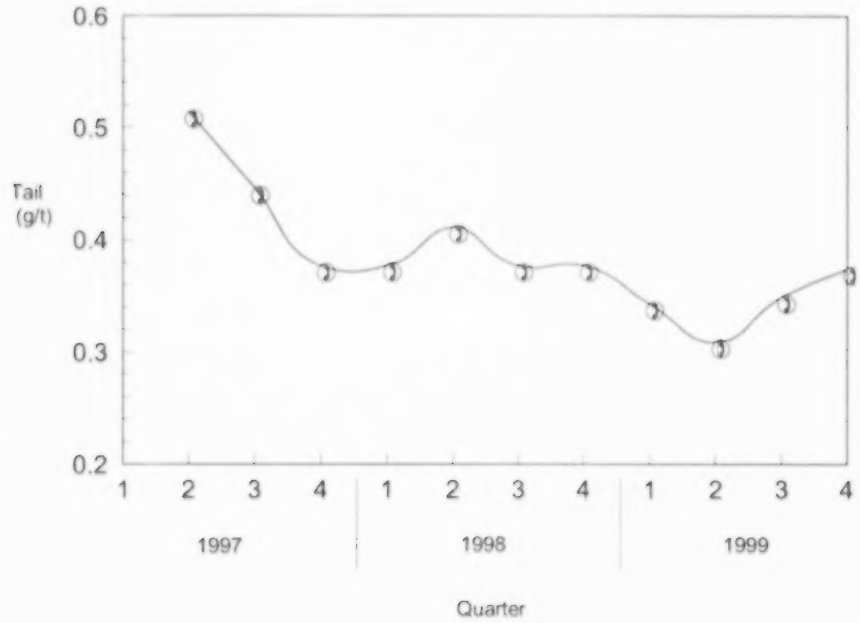

Figure 7. The gold content of the leach residue of the New Britannia Mine ore.